CLAIMS

Having thus described our invention in detail what we claim as new and desire to secure by the Letters Patent is:

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1. A method of substantially reducing the number of tile or divot defects that are present in a silicon-on-insulator (SOI) substrate, said method comprising the steps of:

(a) implanting oxygen ions into a surface of a Si-containing substrate, said implanted oxygen ions having a concentration sufficient to form a buried oxide region during a subsequent annealing step; and

(b) annealing said substrate containing said implanted oxygen ions under conditions wherein said implanted oxygen ions form said buried oxide region which electrically isolates a superficial Si-containing layer from a bottom Si-containing layer, said superficial Si-containing layer having a top surface which contains a reduced number of tile or divot defects so as to allow optical detection of any other defect that has a lower density than the tile or divot defect.

2. The method of Claim 1 wherein step (a) comprises a single oxygen base implant or a base oxygen implant followed by a second oxygen implant, said second oxygen implant is carried out at a temperature lower than the base oxygen implant.

3. The method of Claim 2 wherein said second oxygen implant step is carried out using an oxygen dose of from about 1E14 to about 1E16 cm^{-2} and at an energy of about 40 keV or greater.

4. The method of Claim 3 wherein said second oxygen implant step is carried out using an oxygen dose of from about 1E15 to about 4E15 cm^{-2} and at an energy of from about 120 to about 450 keV.

5. The method of Claim 2 wherein said second oxygen implant step is carried out at a temperature of from about 4K to about 200°C at a beam current density of from about 0.05 to about 10 mA cm^{-2}.

6. The method of Claim 5 wherein said second oxygen implant step is carried out at a temperature of from about 25° to about 100°C at a beam current density of from about 0.5 to about 5.0 mA cm^{-2}.

7. The method of Claim 2 wherein said base oxygen implant comprises a high-dose oxygen implant which is carried out using an oxygen dose of about 4E17 cm^{-2} or greater.

8. The method of Claim 7 wherein said high-dose oxygen implant is performed using an oxygen dose of from about 4E17 to about 4E18 cm^{-2}.

9. The method of Claim 7 wherein said high-dose oxygen implant is carried out at an energy of from about 10 to about 1000 keV.

10. The method of Claim 9 wherein said high-dose oxygen implant is carried out at an energy of from about 120 to about 210 keV.

11. The method of Claim 7 wherein said high-dose oxygen implant is carried out at a temperature of from about 200° to about 800°C at a beam current density of from about 0.05 to about 500 mA cm^{-2}.

12. The method of Claim 11 wherein said high-dose oxygen implant is carried out at a temperature of from about 200° to about 600°C at a beam current density of from about 4 to about 8 mA cm^{-2}.

13. The method of Claim 2 wherein said base oxygen implant comprises a high-energy, high-dose oxygen implant which is carried out using an oxygen ion dose of about 4E17 cm^{-2} or greater and at an energy of about 60 keV or greater.

14. The method of Claim 13 wherein said high-energy, high-dose oxygen implant is carried out using an oxygen ion dose of from about 5E17 to about 7E17 cm^{-2} and at an energy of from about 200 to about 500 keV.

15. The method of Claim 13 wherein said high-energy, high-dose oxygen implant is performed at a temperature of from about 100° to about 800°C at a beam current density of from about 0.05 to about 500 mA cm^{-2}.

16. The method of Claim 15 wherein said high-energy, high-dose oxygen implant is performed at a temperature of from about 300° to about 700°C.

17. The method of Claim 2 wherein said base oxygen implant comprises a low-dose oxygen implant which is carried out using an oxygen dose of about 4E17 cm^{-2} or less.

18. The method of Claim 17 wherein said low-dose oxygen implant is performed using an oxygen dose of from about 1E17 to about 3.9E17 cm^{-2}.

19. The method of Claim 17 wherein said low-dose oxygen implant is carried out at an energy of from about 20 to about 10000 keV.

20. The method of Claim 19 wherein said low-dose oxygen implant is carried out at an energy of from about 100 to about 210 keV.

21. The method of Claim 17 wherein said low-dose oxygen implant is carried out at a temperature of from about 100° to about 800°C.

22. The method of Claim 21 wherein said low-dose oxygen implant is carried out at a temperature of from about 200° to about 650°C at a beam current density of from about 0.05 to about 500 mA cm^{-2}.

23. The method of Claim 1 wherein said annealing step is carried out in an ambient gas that comprises from about 0 to about 90% oxygen and from about 10 to about 100% of at least one high-surface mobility gas that hinders oxide growth, said high-mobility gas is selected from the group consisting of He, N_2, Kr, H_2 and mixtures thereof.

24. The method of Claim 23 wherein said high-surface mobility gases is N_2.

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25. The method of Claim 23 wherein said high-surface mobility gas comprises 100% N_2.

26. The method of Claim 23 wherein said high-surface mobility gas is admixed with Ar.

27. The method of Claim 23 wherein said annealing step is carried out at a temperature of from about 1250°C or greater for a time period of from about 1 to about 100 hours.

28. The method of Claim 27 wherein said annealing step is carried out at a temperature of from about 1300° to about 1350°C for a time period of from about 2 to about 24 hours.

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29. The method of Claim 23 wherein said annealing step includes a ramp and soak-heating regime.

30. The method of Claim 1 wherein said annealing step comprises the steps of: partially annealing the Si-containing substrate containing the implanted oxygen ions in oxygen so as to form a surface layer of oxygen on the Si-containing and to partially form said BOX

region; stripping the surface layer of oxygen; and continuing the annealing to complete formation of said BOX region.

31. The method of Claim 30 wherein said partially annealing is carried out in an ambient that comprises from about 1 to about 100% oxygen and from about 0 to about 99% inert gas.

32. The method of Claim 31 wherein said inert gas comprises He, Ar, Kr, N_2 or mixtures thereof.

33. The method of Claim 31 wherein said gas comprises N_2 or a mixture of N_2 and Ar.

34. The method of Claim 30 wherein said partial annealing is performed at a temperature of from about 1250° to about 1400°C for a time period of from about 1 to about 100 hours.

35. The method of Claim 34 wherein said partial annealing is performed at a temperature of from about 1320° to about 1350°C for a time period of from about 2 to about 20 hours.

36. The method of Claim 30 wherein said surface layer of oxygen is removed utilizing a wet etch process that includes an etchant that has a high-selectivity for removing oxide compared with Si.

37. The method of Claim 30 wherein second anneal is performed at a temperature of from about 1250° to about 1400°C for a time period of from about 1 to about 100 hours.

38. The method of ~~Claim 37~~ wherein said second anneal is performed at a temperature of from about 1320° to about 1350°C for a time period of from about 2 to about 20 hours.

39. The method of Claim 30 wherein said second annealing is performed in an ambient gas that comprises from about 0 to about 90% oxygen and from about 10 to about 100% of at least one high-surface mobility gas that hinders oxide growth, said high-mobility gas is selected from the group consisting of He, N_2, Kr, H_2 and mixtures thereof.

40. The method of Claim 1 further comprising applying a patterned resist to the surface of the SOI wafer prior to oxygen implantation.

41. A silicon-on-insulator (SOI) substrate comprising:

a buried oxide region that is sandwiched between a superficial Si –containing layer and a bottom Si-containing layer, said superficial Si-containing layer having a top surface which contains a reduced number of tile or divot defects so as to allow optical detection of any other defect that has a lower density than the tile or divot defect.

42. The SOI substrate of Claim 41 wherein said buried oxide region has a uniform interface with said superficial Si-containing layer.

43. The SOI substrate of Claim 41 wherein said buried oxide region has an undulating defect-containing interface with said superficial Si-containing layer.

44. The SOI substrate of Claim 41 wherein said superficial Si-containing layer is smooth and has a glass-like appearance.

45. The SOI substrate of Claim 41 wherein said buried oxide region is present continuously through the substrate.

46. The SOI substrate of Claim 41 wherein said substrate comprises discrete and isolated buried oxide regions.

47. The SOI substrate of Claim 46 wherein some of said discrete and isolated buried oxide regions have an undulating defect-containing interface with said superficial Si-containing layer.